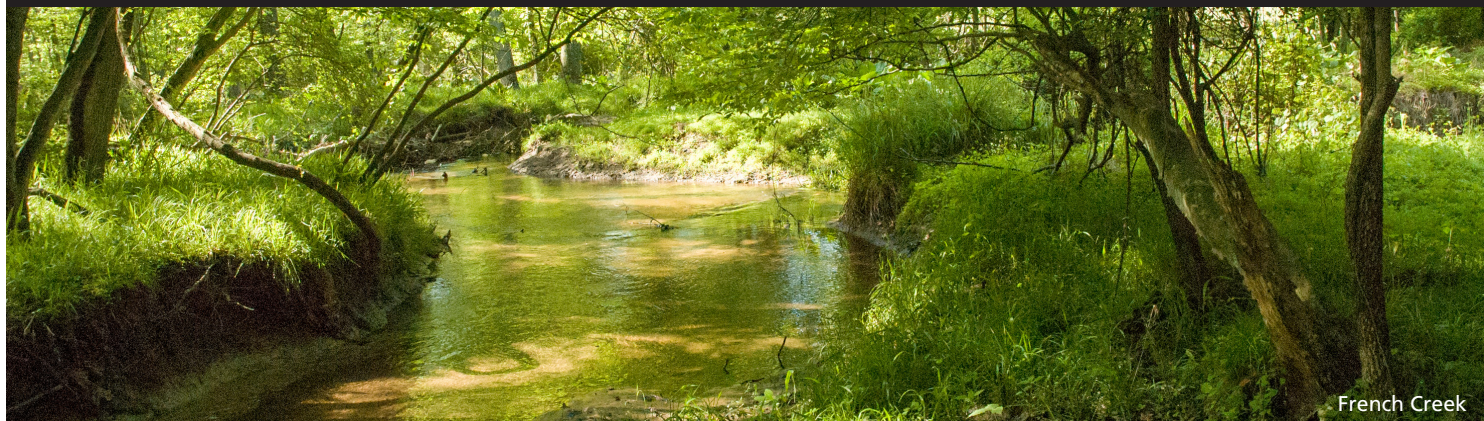




French Creek

An Introduction to the Water Resources of Hopewell Furnace National Historic Site

Hopewell Furnace National Historic Site (HOFU) preserves one of the finest examples of a rural American 19th century iron plantation found in the country. Today HOFU consists of the historic village situated on 848 mostly wooded acres. The park is located along the banks of French Creek in the Piedmont region of southeastern Pennsylvania. The Hopewell Furnace refined iron ore by harnessing power from French Creek (through the use of a water wheel) and from charcoal produced from hardwood trees in the adjacent forests. French Creek still flows nearby and remains an important resource to the park today. This brief provides an introduction to the natural resources of French Creek and other water resources at HOFU.

Landscape Setting and Land Use

It is important to describe the landscape surrounding HOFU to better understand the water resources. Land use is particularly important because it has a large influence on the protection or pollution affecting a stream. Land use is also the feature on the landscape which we control through management, policy, or other human activities.

HOFU is located in the Schuylkill River basin within the Delaware Bay watershed. Geologically speaking, the landscape is diverse and is composed of sedimentary, igneous, and metamorphic rock. The watershed around HOFU remains relatively undeveloped due to its location next to French Creek State Park and within the Hopewell Big Woods Conservation Area. However, two impoundments are located on French Creek inside the state park and immediately upstream of HOFU boundaries.

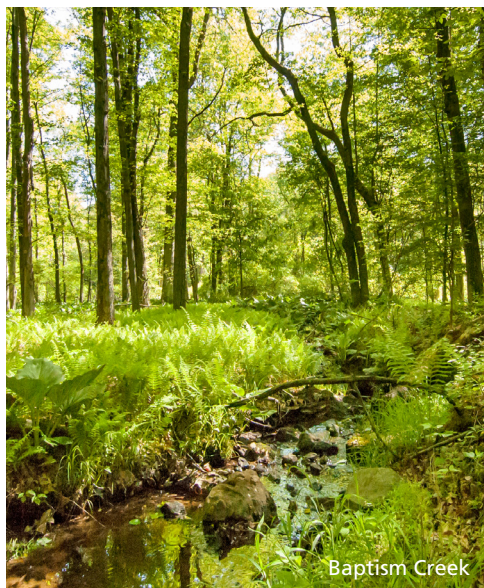
Within HOFU the primary land use class is forest (69.9%), followed by agricultural (11.1%) and developed (11.0%; see map and table, page 2). The contributing watershed for HOFU is similar but has more land devoted to forest (78.3% Forest; 5.8% Agricultural, and 8.1% developed). The region (i.e. watershed for the Delaware Bay) has substantially less

Headwater Streams

- All of the streams in HOFU are headwater streams (i.e. drain small watersheds).
- Healthy headwater streams are generally well-shaded with fully forested riparian communities.
- In aggregate, headwater streams play a major role in nutrient and sediment delivery downstream.
- These small streams can be highly influenced by riparian disturbance and nearby land use.

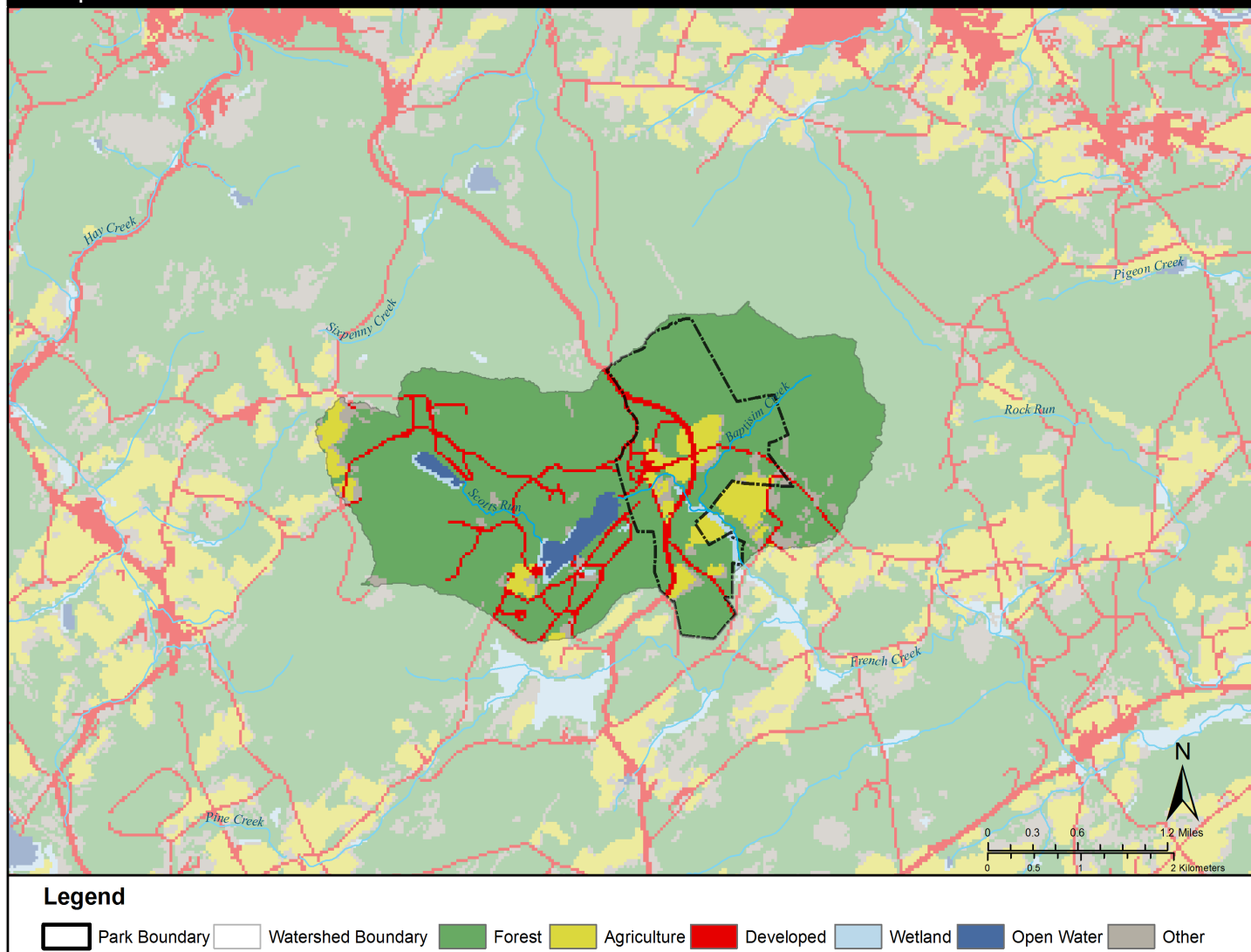
forest (45.6%) and nearly double the agriculture (19.7%) and development (20.4%). Recent surveys of wetland areas suggests over 77 acres of wetlands can be found in HOFU. These wetlands consist of seasonally flooded forests and shrublands. The most common wetland type is the Red maple mixed hardwood palustrine forest.

The high percentage of surrounding forest is important for understanding stream conditions at HOFU. Forested watersheds (and associated buffers around streams) have the ability to improve stream conditions. Forests and buffers can remove nutrients, limit water temperature increases, and protect physical habitat. In contrast, agriculture and urban development can cause degradations in water quality and stream habitat. The high percentage of forests in and around HOFU help protect its water resources.



Baptism Creek

Hopewell Furnace National Historic Site - Land Use



Land Use Type	Within Park		Within Surrounding Watershed		Within 100 m. Riparian Buffer in Surrounding Watershed		Within Delaware Bay Watershed (DBW)	
	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)
Forest	69.9	2.4	78.3	10.6	53.7	0.8	45.6	15,267
Agriculture	11.1	0.4	5.8	0.8	5.2	0.1	19.7	6,606
Developed	11.0	0.4	8.1	1.1	5.0	0.1	20.4	6,816
Wetland	4.0*	0.1*	4.1	0.6	33.8	0.5	11.5	2,216
Other	4.0	0.1	3.7	0.5	2.3	<0.1	2.8	2,548

Land use map and table. Note that HOFU and the surrounding watershed contain a greater percentage of forested lands and a lower percentage of developed and agricultural lands compared to the DBW. *Wetland area likely underestimated (see text, page 1).

Aquatic Resources

The National Park Service manages approximately 5.2 km (3.2 miles) of streams at HOFU. The entire park is drained by French Creek. French Creek enters the park from the west and flows through the heart of HOFU. Upstream of the park, French Creek is impounded twice. Baptism Creek, a tributary of French Creek, drains the northwestern portion of HOFU along with additional lands, primarily in the state park. French Creek (including Baptism Creek) was designated as an Exceptional Value stream by

the Commonwealth of Pennsylvania because of its outstanding natural and scenic values.

French Creek supports a diverse assemblage of fish (i.e. 17 species), most of which are typical of a warmwater ecosystem (e.g. largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), etc). In contrast, Baptism Creek contains a coldwater ecosystem that supports brook trout (*Salvelinus fontinalis*), a species dependent on cold water.

Benthic Macroinvertebrates

In order to monitor stream health, MIDN also collects information about benthic macroinvertebrate communities in HOFU. Benthic macroinvertebrates are aquatic invertebrates that can be observed with the naked eye. In HOFU, benthic macroinvertebrate sampling occurs at two sites. After identifying the macroinvertebrates, MIDN is able to calculate an “index of biological integrity” (IBI) based on the number of individuals and species present. This index can then be used to assess the health of the stream. Since both French and Baptism Creeks have been designated as exceptional value by the Commonwealth of Pennsylvania, they are expected to have a higher IBI scores than other streams. Initial macroinvertebrate data collected by MIDN from French Creek is inconclusive and additional samples are needed. In contrast, macroinvertebrate data from Baptism Creek is more definitive — IBI scores from Baptism Creek indicate healthy environmental conditions.



Megaloptera larvae (“Hellgrammite”). This impressive predator will eventually develop and hatch into an adult dobsonfly.

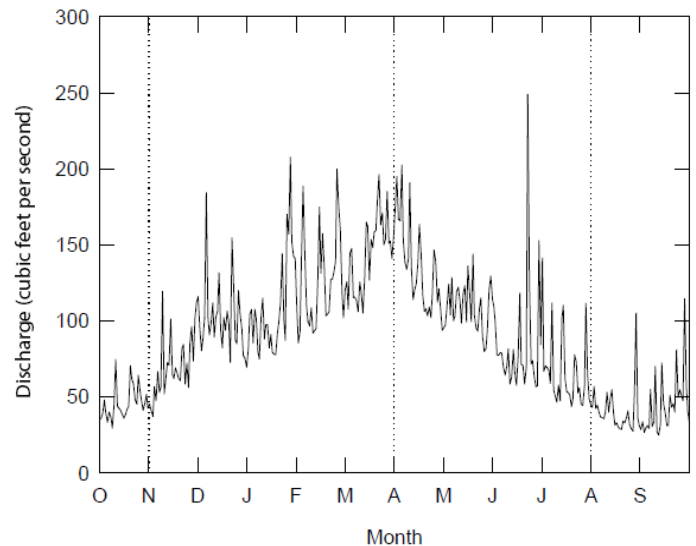
Aquatic Resources continued...

Including brook trout, HOFU supports 18 species of fish. A total of 71 genera of benthic macroinvertebrates have also been observed. In addition, 19 amphibian species and 22 reptile species have been documented. Seven plant species of special concern have also been found in park wetlands.

Water Quality Assessments

Historical water quality data for HOFU is limited. Even so, the Commonwealth of Pennsylvania did assess all the waters in HOFU during the 2014 assessment cycle. No streams were listed as impaired in the park or in the surrounding watershed (see map, page 4).

Most recently, the Mid-Atlantic Network Inventory and Monitoring Program (MIDN) has been monitoring water quality and benthic macroinvertebrates to assess stream conditions at HOFU. As of the publication date of this document, no measured parameters indicated an impaired status with respect to state standards (see Water Quality Impairment box, page 4). Nevertheless, the upstream impoundments do cause abnormally high water temperatures in French Creek. It is possible that these increased water temperatures may have a negative impact on the ecological health of French Creek. That said, data to date are inconclusive. In contrast, macroinvertebrate sampling in Baptism Creek has documented sensitive coldwater fauna and a definitively healthy macroinvertebrate community.



Hydrograph

The figure above shows a representative hydrograph that reveals patterns of stream discharge (cubic feet per second) for waters in HOFU. There is a trend of increasing flow from November to April, followed by a trend of decreasing flow from April to August. The lowest flow period is from August to November. These patterns can help interpret stream conditions throughout the year. For example, during low flow periods, dissolved oxygen readings are generally lower. This occurs due to lower stream flows, higher seasonal air and water temperatures, and other associated ecosystem processes.



Water Quality Sampling

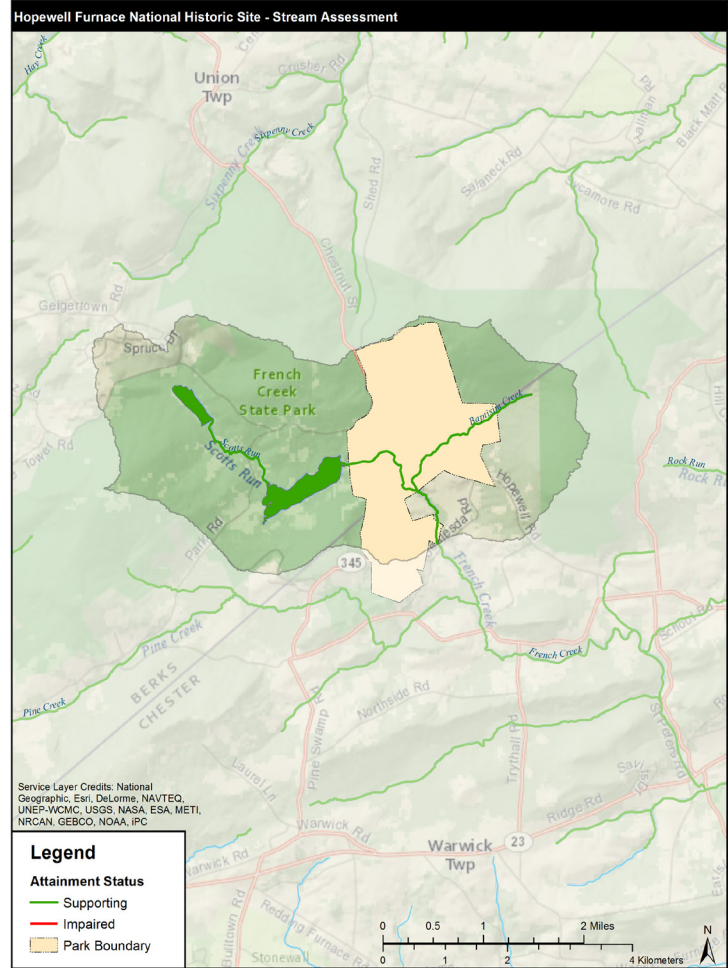
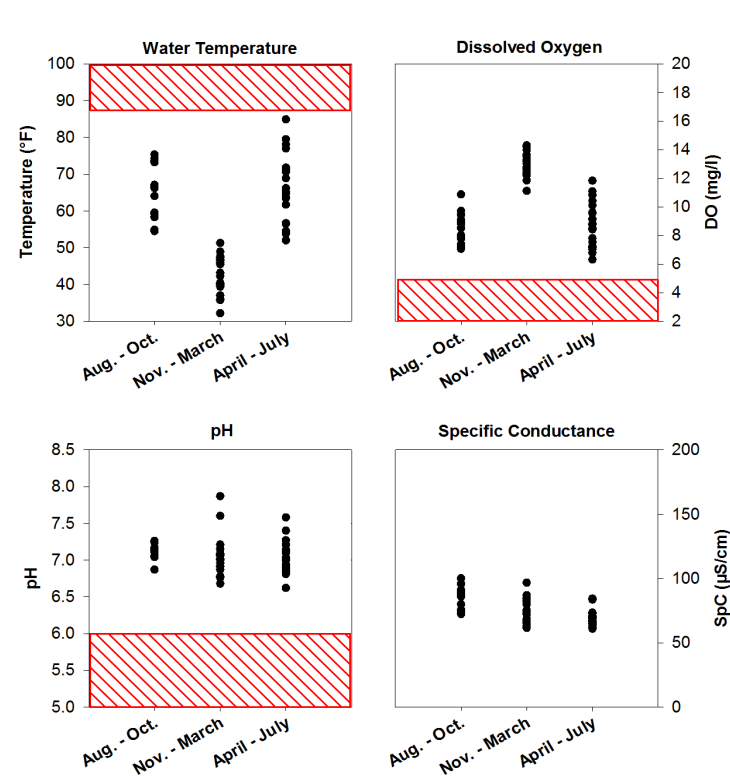
Long-term monitoring of water resources in HOFU

In order to better monitor the status and trends of wadeable streams at HOFU, the Mid-Atlantic Inventory and Monitoring Program (MIDN) has established several long-term monitoring sites. These sites were placed in streams of significant value as determined by HOFU and MIDN staff. There is one monitoring site on French Creek and another on Baptism Creek. The two sites are located on their respective streams just above the confluence. At each site, MIDN staff measure water temperature, specific conductance, pH, and dissolved oxygen concentrations. Some sites contain automated equipment that records this information many times a day. MIDN staff also record observations about the weather and discharge stage. In some sites, data on benthic macroinvertebrates is also collected.

Water Quality Assessments continued...

The lands in and around HOFU are well protected and local aquatic resources are relatively healthy. Even so, the upstream impoundments might be influencing HOFU aquatic ecosystems by elevating stream temperatures dur-

ing summer seasons. For additional information, please visit https://science.nature.nps.gov/im/units/midn/monitor/water_quality.cfm.



HOFU stream assessment map (above). See “Water Quality Impairment” box to left for details.

Water Quality Impairment

Generally speaking, when discussing water quality, the term “impairment” refers to the failure to meet standards established by individual states as required by the Clean Water Act. The figures above show scatterplots for “core” water quality parameters measured in HOFU by MIDN (2011-2013). The data are grouped by hydrologic season (see “Hydrograph”, page 3). Each dot represents a data point. Red hatched areas in the figure show where impairment occurs as determined by the Commonwealth of Pennsylvania. (At present, there is no impairment threshold for specific conductance). Based on MIDN data, none of the sites are considered impaired according to these state standards. In addition, the Commonwealth of Pennsylvania also assessed both streams in HOFU during the 2014 assessment cycle (see map, right). Based on that assessment, no streams are impaired within the park or in the surrounding watershed.



Photos courtesy of the National Park Service.

Lead Scientist
Nathan Dammeyer
Nathan_Dammeyer@nps.gov
Aquatic Ecologist

Mid-Atlantic Network
120 Chatham Lane
Fredericksburg, VA 22405
<https://science.nature.nps.gov/im/units/midn/>

Parks monitored: Appomattox Court House NHP • Booker T. Washington NM • Eisenhower NHS • Fredericksburg & Spotsylvania NMP • Gettysburg NMP • Hopewell Furnace • NHS Petersburg NB • Richmond NBP • Valley Forge NHP